GMRT Observations and modelling of GRB030329 Afterglow

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in collaboration with

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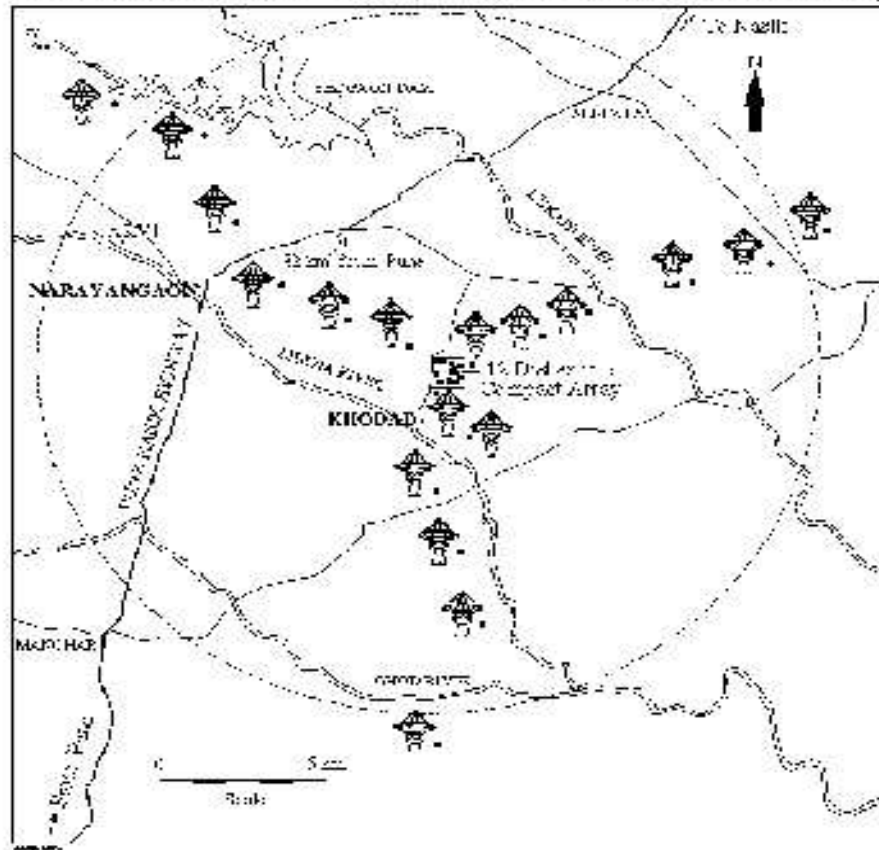India

Afterglow Longevity

- Afterglow remains 'visible' longer in Radio
- GRB 970508 for more than an year
- Extensive monitoring possible in Low frequency radio

The GMRT Telescope

LOCATIONS OF GMRT ANTENNAS (30 dishes)

- Array of 30 Antennas
- 25km distance
- 45m Diameter Dishes

The GMRT Telescope

www.gmrt.ncra.tifr.res.in

- Array of 30 Antennas

- 25km distance

- 45m Diameter Dishes

- Currently operates at 1420 MHz, 610 MHz, 325 MHz, 235 MHz and 150 MHz

- Sensitivity $\sim 100\mu$ Jy with ~ 2 hrs integration (at 1420 MHz)

Observations of GRB030329 Afterglow

- First observation at 1280 MHz 2.3 days after the trigger

- $330 \pm 40 \mu$ Jy

  Ref : Rao, A. P., Ishwara-Chandra, C. H., Bhattacharya, D. GCNC 2073

  Ref : Rao, A. P., Ishwara-Chandra, C. H., Bhattacharya, D, Castro-Tirado, A. J. GCNC 2268

- Continuing the monitoring for 2 years

- At 610 MHz the observations started almost 9 months after the burst and is still continuing

- Upperlimit in 325 MHz

Modelling the afterglow

We modelled the multiband observations of this afterglow following two models

(i) The double jet model (Berger et al 2003) to explain the 1.5 day optical flux enhancement and the second jet break

(ii) A refreshed jet model to explain the 1.5 day rebrightening and the 10 day jet break

Both the models give almost similar E_{tot} and n

Resmi L, Ishwara-Chandra C H, Castro-Tirado A J, Bhattacharya, D et,al, 2005

Modelling the afterglow

- The final jet of the refreshed shock model gives
- At 9.8 days,

f_m (mJy)	ν_a (GHz)	ν_m (GHz)	ν_c (Hz)
$44.7^{+1.}_{-2.}$	$11^{+3.}_{-0.5}$	$39.8^{+5.}_{-1.}$	$5^{+2.}_{-1.5} \times 10^{14}$

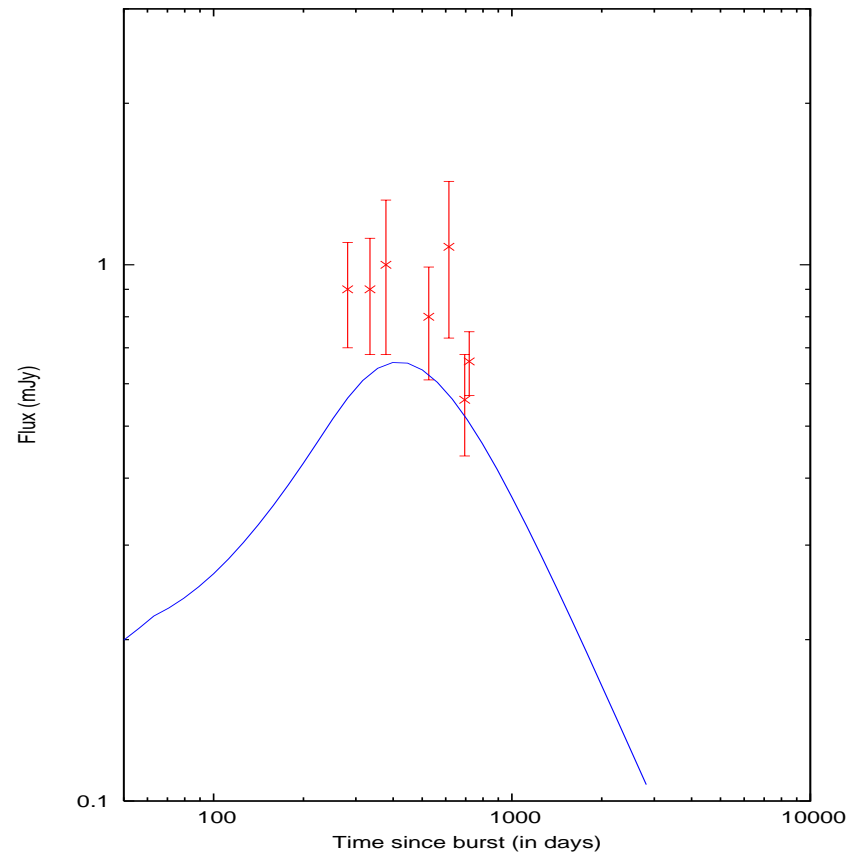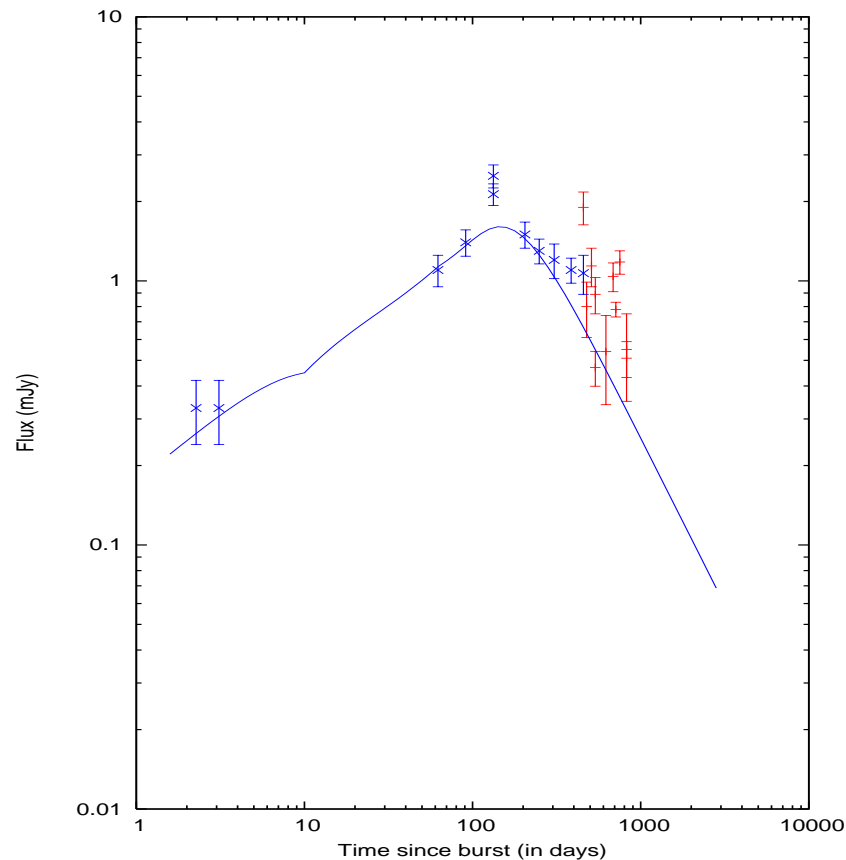| t_j day	t_{nr} day	p
$10^{+2.3}_{-1.0}$	63^{+14}_{-30}	2.24 ± 0.02

Estimation of Physical Parameters

For the refreshed shock model (the final jet)

E_{tot} (ergs)	n (atoms/cc)	ϵ_e	ϵ_B	θ_j degrees
$5.8^{+5.9}_{-1.7} \times 10^{48}$	$6.7^{+13.}_{-3.}$	$0.1^{+0.05}_{-0.01}$	$1.0^{+1.}_{-0.5} \times 10^{-3}$	$20.5^{+0.1}_{-0.03}$

For the wide jet model (the second jet)

E_{tot} (ergs)	n (atoms/cc)	ϵ_e	ϵ_B	θ_j degree
$5.0^{+3.3}_{-2.1} \times 10^{48}$	$8.6^{+12.}_{-5.}$	$9.0^{+3.}_{-1.} \times 10^{-2}$	$11.9^{+10.}_{-7.} \times 10^{-3.}$	$23.3^{+0.0}_{-0.0}$

With the Model

1280 MHz Observations   610 MHz Observations

- Extension of the model to the late data

Conclusions

- Lowest Frequency and Longest Ever Coverage of the Radio Afterglow

  Constraints on self absorption frequency of the emitting region and non-relativistic transition time of the fireball

  The data can be well fit by a model where the two jets are present either simultaneously or in exclusion of each other

Conclusions

- Lowest Frequency and Longest Ever Coverage of the Radio Afterglow

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  The data can be well fit by a model where the two jets are present either simultaneously or in exclusion of each other

- The 1280 MHz peak is not explained

  Early 100 GHz observations and $SCUBA$ submillimeter observations seem to indicate a flat lightcurve which extends to even $t < 1.5$ days

Conclusions

- The low frequency radio observations are important in probing the late time evolution of the fireball

- Continuation of the radio monitoring could reveal possible non-standard features (eg., flattening, see Frail et. al. 2004) in the late radio evolution.

- Could give hints to the microphysics of the Shock

THANKYOU!!

Modelling the afterglow

- The wide jet

- At 9.8 days,

f_m(mJy)	ν_a (GHz)	ν_m (GHz)	ν_c (Hz)
$44.7^{+1.}_{-2.}$	$13^{+2.5}_{-0.6}$	$39.8^{+5.}_{-1.}$	$3.98^{+1.3}_{-2.0} \times 10^{14}$

t_j day	t_{nr} day	p
$10^{+2.3}_{-1.0}$	42^{+17}_{-7}	$2.3^{+0.05}_{-0.02}$

Why Refreshed Jet?

- The flux past 1.5 days can be well produced by the wide jet alone. *ie* both jets need not be present simultaneously.

- Episodes of re-energization is known before, giving rise to brightness enhancements in the lightcurve. Granot, Nakar, Piran 2003